



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

## THE NATURE AND AMOUNT OF BIOLOGICAL WORK THAT CAN PROFITABLY BE ATTEMPTED IN SEC- ONDARY SCHOOLS

THE purpose which the instructor has in mind will determine the "nature" of the biology which he teaches. The purpose of biology in the secondary schools from the writer's point of view can be stated under three heads, which will be named in the order of their importance.

### I. TO DEVELOP A LOVE—OR AT LEAST A LIKING—FOR NATURE

Successful work will invariably depend upon this. Biology is the hardest study on earth to cram down an unwilling throat. Algebra *may* be hammered in, but biology never! It is easy enough to awaken enthusiasm in the pupil—not enthusiasm of the "Oh my" order, that will admire the air-bubbles under a microscope, but enthusiasm that will put life into dry bones and inspire the pupil, which comes only after hard work on his part. The pupil should be made to realize early the dignity of biology and to have respect for it—to realize that, in his own parlance, "it is no snap," for easy acquisitions are not often highly prized. My most beloved teacher was the one who worked me the hardest. To develop in the pupil this appetite for the subject, *variety* should be served. Too much time should not be spent on a single type, because the secondary school is not the place for exhaustive study. The naturalist side should be fostered, and the imagination should not, in the name of science, be frost-bitten.

### II. TO TRAIN THE PUPIL IN THE SCIENTIFIC METHOD

This training should give the pupil independence of books and dependence upon nature. It should cultivate the stone-turning frame of mind which seeks to know what may be on the under side of things. It should develop accuracy in observation, common sense in interpreting those observations, and power to

express conclusions in good straight-forward English. Doubtless the laboratory is the best agent for such a training, but a well-equipped "modern" laboratory is by no means indispensable. Too many conveniences tend sometimes to defeat the very ends which laboratory work has in view. The machinery of demonstration may obscure the demonstration itself. The story of the young biologist who journeyed half way across the British Isles to see Darwin's laboratory, only to be shown a wooden box of dirt, a motley row of bottles, and a broken saucer, points its own moral.

### III. TO IMPART BIOLOGICAL DATA

Much of the misunderstanding between biology teachers and the public arises from the fact that the public at large believes that the acquisition of facts about living things is the prime object of biology, whereas it is the least object. The natural hunger of the human mind for facts will take care of this phase of biology. It is important that one clear general system of classification should be advanced, so that the facts acquired will find proper pigeonholes in the pupil's mind. After the school-days are over, those pigeonholes may gradually be filled in a normal manner. They should not be stuffed with job lots of information in the name of biology. There must be a certain ballast of scientific nomenclature, but woe to the instructor who takes aboard too much of such ballast! Supplementary talks should be given in the nature of excursions from the known to the unknown in the living world; and in these talks should be kept constantly in mind the conception of the organic unity of all biological data. The fundamental theory of the evolution of organic life and an explanation of the process of "natural selection" should surely be unfolded when data enough have been mustered to make it intelligible. I have found that even first-year high-school pupils are keen to appreciate the greater conceptions of biology if they are given the chance.

To summarize thus far: the nature of biology taught should be determined by keeping in mind the fact that most important of all is to develop a love for the subject; next, to train the

pupil in scientific methods of observation and deduction; and, lastly, to impart to the pupil a certain array of biological facts.

The *amount* of biology that can be practicably undertaken depends largely on the *nature* of it. Of course, more can be done if the pupils like it. The attitude of the instructor's superiors and the grade of the pupils taught are other important factors. The most practical way to indicate the amount of biology which may be profitably attempted will be to outline briefly what we have been doing at the North Division High School with second-year pupils in forty weeks of four single periods each. The conception of the cell in its various forms—the very alphabet of biology—should be gained at the very start. 'This may perhaps be done best with some small egg, like that of the worm *Ascaris megalocephala*, or of some Echinoderm, rather than with the classical and illusive *Amoeba*. From this typical round cell can be shown theoretically how other cells may be derived by modification; as, for instance, the elastic muscle cell by stretching it out; the shingle-like epithelial cell by flattening it; the bone-cell by thickening its walls; and the nerve fiber by drawing it out like a telegraph wire. This, of course, necessitates at the outset the mastery of microscopic technique on the pupil's part, at least so far as a low-power objective is concerned.

Under the *Protozoa*, *Paramæcium* and *Vorticella* are good types to use, because they move about and catch the eye directly. When fed with powdered carmine, they show in short order, under a raised coverglass, the process of primitive digestion, and thus introduce the pupil early to the conception that biology is not the study of dead things alone.

Under the *Cœlenterates* we have used the small sycon sponge—*Grantia*—with greater success than *Spongilla*. A slide of *Grantia* may be prepared for lens-study by affixing to it, with balsam and without coverglass, a dry razor-cut cross-section, and near it a longitudinal half of the entire animal cut open, as a sugar melon is prepared for breakfast. From this a clear idea of the sponge plan can be gained, such as *Spongilla* would never give. Coming to *Cnidarian Cœlenterates*, we use *Hydra*, both alive

and in balsam preparations, and as supplementary to this, two hydroids—*Pennaria* and *Obelia*, with a hydro-medusa—*Gonionemus*; also by way of demonstration, corals, sea-anemones, medusæ and as many of their wonderful kith and kin as are within reach.

The eccentric *Echinoderms* are valuable as interest-excitors, especially to inland pupils. The classical starfish and the sea-urchin together are excellent material with which to develop ideas of homology and analogy. There is no time, however, for much internal anatomy.

We do not attempt a very exhaustive anatomical acquaintance with the earthworm, but nevertheless we become very good friends with it. Live worms in a glass of soil are given to each pupil and the study of them is directed principally to their activities with enough structure to make things clear. Those pupils who at first are inclined to be squeamish at the idea of handling those "nasty things" are almost always sorry to see the worms go.

The *Arthropoda* demand a considerable length of time, because it is such an extensive and varied branch. The crayfish is a model laboratory animal and, used alive as well as freshly boiled will excite questions that will lead up to a profitable conception of differentiation and adaptation. The internal anatomy, which is so apt, with high-school pupils, to degenerate into sloppy musing, is avoided. With the insects we take occasion to emphasize the importance of classification in biology, and to that end plan exercises in identification of *orders* (not species), using all the material that we can muster. We have been fortunate enough to have live mosquitoes (by visiting the liquid manure barrels in the greenhouses for eggs) in all the stages of their life cycle, and this is a study that never fails to be of interest and profit.

In the *Mollusca* the clam may be observed alive and studied after being hardened in formolose. Snails may be bred and watched in aquaria, and newly-hatched snails observed under the microscope while their shells are yet so transparent that the heart can be seen to beat.

One day's morphological study of the squid, to show what can be done with the molluscan plan if the shell is discarded, supplements the clam study.

Of all the groups *Vertebrates* are, perhaps, the hardest to teach in secondary schools. Much of this work must be done outside the laboratory. We always wedge in a trip to the museum at the Academy of Sciences, for the mammals, and reference to the "Zoo" in Lincoln Park is repeatedly made. According to our experience the frog is a better type for laboratory work in this important branch than the perch, which is often used, but the study should be begun with living frogs. Incidentally, let me say that fresh perch, left over night in 4 per cent. formolose, lose their fishy smell and are much firmer and pleasanter to handle. We have also had laboratory work on sets of tadpoles of various ages, and on bird skins.

Nowhere do we expect to attempt much internal anatomy, except by demonstration. The place for that, out of respect for popular prejudice, if for no other reason, is for the present beyond the secondary school. Every animal study in the laboratory should be prefaced, whenever possible, by an acquaintance with the living animal. Our science should be *biology*, and it should not degenerate into what has aptly been termed "necrology."

According to our course botany must follow zoölogy. In this part of biology much the same plan is attempted as in zoölogy. The physiological side is emphasized and general bacteriology is not forgotten. *King Chlorophyl* is enthroned at the start, and our allegiance to him made clear. The lower forms are studied long enough to develop clearly the idea of evolution of sex. The analysis and preservation of flowering plants are kept in the background to make room for the more important philosophical consideration of such topics as the relation of animals and plants; the distribution of seed; the devices for cross-fertilization; the defenses of plants against climate and enemies; the influence of soil on plants and plants on soil; the aristocracy of weeds; the struggle for existence, etc. These subjects can be brought out by laboratory work and in the scientific method. For instance, we

made one very interesting and profitable day's study last year on a single square foot of turf and weeds brought in from the alley behind North Division High School.

If a year's work like this is successfully carried out, the result ought to be, not a few specialists, who would have developed in spite of the instructor, but a high average of eye-opened pupils with a desire to learn more, and with some degree of skill in knowing how to know—instead of pupils having that impervious varnish of thinking they have finished the subject.

HERBERT E. WALTER

NORTH DIVISION HIGH SCHOOL  
Chicago